Case Study of the Environmental Vulnerability of a Small Catchment “Cuenca de la Quebrada Cuevitas”, Yeguare Region, Honduras

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1 Introduction

This paper describes the vulnerability of a small catchment affected by rainfall and mountain stream flows. The study area is “Cuenca de la Quebrada Cuevitas”. This small catchment received intensive damage from landslides during hurricane Mitch in 1998. Although road access and water capture structures were reconstructed the watershed as a whole, remains susceptible to erosion and slope instability. The site is located in the hills of Uyuca’s Biological Reserve in the Yeguare Region, 20 kilometers east of Tegucigalpa, Honduras. The site is very important in terms of water supply for Zamorano and surrounding communities and as communication hub between Tegucigalpa, the Honduran capital, and the east region.

First, we subdivided the “Qda. El Gallo watershed” into its smaller land units or micro-catchments of “Qda. Agua Amarilla” and within this “Qda. Cuevitas”. Then, we analyzed the catchment area of “Qda. Cuevitas” with regard to the geomorphological features of the stream network. Secondly, we performed a detailed geological survey for the “Qda. Cuevitas” catchment which belongs to “Cuenca de la Agua Amarilla”, a third order drainage of the “El Gallo”. The “Qda. Cuevitas” drainage area is the largest, indicating its geologic susceptibility to erosion by water.

In the study, we consider the risks and vulnerability of civil infrastructure such as the road and the water facilities that belong to Zamorano. In that regards, we investigated the sources of slope instability and associated soil deposits in valley and contrasted them with its geological features. Preliminary findings indicate that drainpipes under the road lost their connectivity. This allowed runoff to go through and in some cases deposit coarse materials (sand and gravel), which in turn obstructed the normal flow of water and sediments. Based on these preliminary findings, we prepared a draft plan which included a set of recommendation to improve affected infrastructure and minimize the risk of being affected in the future. The study of the sources of vulnerability of a small catchment is most important step to draft an affective plan to reconstruct and protect infrastructure before and/or after damage by natural and human induced disaster.

2 Study site “Qda. Cuevitas”

The study site is located within the small catchment of “Qda. Cuevitas” nearby Zamorano, Honduras.

In term of its geomorphological features, el Benque, with the largest sub-catchment area in the main-catchment “Cuenca de la Agua Amarilla”, is very fragile and susceptible to erosion (Fig. 1).

Fig 1. Topographic map with the river system.

Such a relationship between a sub-catchment and main-catchment, is similar to the relationship between sub-catchment “Agua Amarilla” and the main-catchment “El Gallo”. In term of its geological origins, there are much tuffaceous sediments of the Cenozoic era, for instance, tuff, lapilli tuff, detritus, mud flood, and rock avalanche (Fig. 2).

Fig 2. Outcrop of tuff and flood deposits.
Looking at the relationship between geomorphic and geologic features, we concluded that the hillside is easy to erode. This in turn needed to be taken into account when designing and building the road and associated drainage infrastructure and water capture structures as well.

3 Hurricane Mitch and natural disaster

Honduras suffers from two types of natural disasters, landslides and flooding caused by intensive rain during tropical storms and hurricanes. The country’s mean annual precipitation ranges from 1,000 to 1,500 mm.

When Hurricane Mitch struck Honduras, mud flows on “Cerro el Berrinche” intruded into the Río Choluteca, obstructing normal stream flow by creating a small earthen dam that flooded Comayagüela and parts of Tegucigalpa. Rainfall by Hurricane Mitch in the capital city of Tegucigalpa totaled 281 mm. This was however much less than the one measured in Choluteca, which was more than three times the precipitation by hurricanes “Gilberto” and “Fifi” (Servicio Meteorologico Nacional, unpub. Data; after Harp, E.L., et al., 2002). Rainfall by Hurricane Mitch in Tegucigalpa is shown in Fig. 3.

El Benque, located 20 km from Tegucigalpa, was affected by flooding, most commonly debris flows which were concentrated in “Qda. Agua Amarilla” and “Qda. Cuevitas”. Debris flow from these catchments affected the lower village of “Jicarito” where at least 84 houses were destroyed, during Hurricane Mitch. There are still some signs of the damage in two gorges caused by Mitch (Fig. 4).

4 Vulnerability of the small catchment

During our field surveys it was important to consider the river system and sub-catchments that made up the main-catchment when we assessed the vulnerability of slopes. The relationship of the catchment “Cuevitas” and the catchment “Agua Amarilla” in the catchment “El Gallo” is fractal, like nested boxes. The most vulnerable catchment is the “Qda. Cuevitas” which shows signs of widespread erosion on the hillsides and along the stream banks. The road in Benque site was damaged by heavy traffic of trucks and cars after the rainfall events wet the loose compacted road material. The road sagged and drainpipes under the road disconnected from each other, creating gaps ranging from 0.2 to 0.5 m (Fig. 5). Drainpipes subsidence intensified due to water seepage through the cracks, which increased as solution cavities formed and fine grained materials were washed away.

5 Concluding Remarks

1) In the small catchment of “Qda. Cuevitas”, there are still some signs of slope instability and environmental damage caused by Hurricane Mitch in 1998 which are affecting Zamorano’s water supply and the road access to Tegucigalpa.

2) Tuff and volcanic sediments are easy to erode, which reflects catchment’s geomorphological feature; for instance, the size of sub-catchment within its main-catchment.

3) Subsidence of the road is caused by heavy rain and traffic load, leading to cracks of drainpipes under the road.

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References